2006 RESEARCH PROBLEM STATEMENT

Problem Title:	Assessment of Mud Balance Test for Quality Assurance in Ground Anchor Installation	**No.: 06.07-3**
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1. Briefly describe the problem to be addressed:

In the Provo Canyon Reconstruction Project we are installing thousands of feet of ground anchors (ie soil nails and rock dowels). Our current specs require the contractor to take two cube samples per day and test them to verify the grout strength. This allows verification of the grout strength at 14 days and 28 days after installation as to whether the grout met strength. However, in the meantime the Contractor can be several rows lower and if there is a problem it is almost too late too fix it. The Post Tensioning Institute recommends using the mud balance test as a means of testing the grout strength upfront. The correlations between the specific gravity (which is measured with the mud balance) and compressive strength are very good for a grout comprised of only cement and water, which is what is being used as nail grout. Grout cubes are still taken periodically to ensure that the correlations are being met. We proposed at one point a while ago that this method be used on the Provo Canyon Reconstruction, but were rejected because UDOT is unfamiliar with the mud balance test. We propose to gather cube samples from the actual construction project, perform the mud balance on the same batch of grout, and gather a set of data from the field that show the correlations between the two.

2. List the research objective(s) to be accomplished:

1. Literature search on the specific gravity (mud balance) test.

2. Use the current construction as a means of gathering mud balance and grout cubes results to show the correlations between the two.

3. Recommendations for any adjustments that may need to be made to the soil nail / rock dowel specifications.

3. List the major tasks required to accomplish the research objective(s):	**Estimated person-hours**
1. Literature search and review.	10 hours
2. Perform mud balance and make grout cubes.	Time Donated by Provo Canyon Team
3. Break grout cubes.	Cost to Break Each Cube (5 hours per week)
4. Compile correlation curves.	Time Donated by Provo Canyon Team
5. Report and Recommendations for Spec Change	20 hours
6.	

4. Outline the proposed schedule (when do you need this done, and how we will get there):

The contactor is currently installing soil nails and rock dowels and will be throughout the summer. As soon as we can get things in place we can begin gathering data. They mix up many batches of grout throughout the day at several different locations on the project, so we can also test at various times of the day and in various locations along the project. We anticipate that the work will have to be done by the end of summer though as the soil nails / rock dowels will hopefully be completed.

5. Indicate type of research and / or development project this is:

Large: ☐ Research Project ☐ Development Project

Small: ☒ Research Evaluation ☐ Experimental Feature ☐ New Product Evaluation ☐ Tech Transfer Initiativ

☐ Other_____

6. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?

UDOT staff (Provo Canyon Team), possibly consultant performing the actual cube breaks.

7. What deliverable(s) would you like to receive at the end of the project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)

The current specification is not a standard specification, but rather a special, since it is only used on a project here or there. However, recommendations as to how the spec can be modified allowing for better QA/QC.

8. Describe how will this project be implemented at UDOT.

Future projects that use soil nails and rock dowels may utilize the mud balance of a means of testing up front and verifying the strength immediately as opposed to having to wait the two to four weeks to make sure we are meeting the desired strength.

9. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be.

By using the mud balance with periodic cube sampling to verify the correlations, it is felt by the champions of this proposal that a better end product (soil nails and rock dowels) can be achieved. There is definitely the possibility to identify potential problems up front rather than waiting for the cube breaks.

10. Describe the expected risks, obstacles, and strategies to overcome these.

The mud balance and cube sample construction take place in the field, right in the mix of the construction environment. This sometimes allows for error to creep into the data, as opposed to being done in a pristine lab environment. However, this can also be a good thing, as the numbers show what is really happening in a real life situation. Those performing the mud balance and cube samples will have to identify a uniform way of doing this to eliminate error.

11. List the key UDOT Champion of this project (UDOT employee who will help Research Division steer and lead this project, and will spearhead the implementation of the results): Clifton Farnsworth and Jim Golden (Region 3 Construction)

12. Estimate the cost of this research study including implementation effort (use person-hours from No. 3): $3000 - $5000

13. List other champions (UDOT and non-UDOT) who are interested in and willing to participate in the Technical Advisory Committee for this study:

Name	Organization/Division/Region	Phone
A) Clifton Farnsworth	Region 3 Construction – Provo Canyon Crew	801-830-9314
B) Jim Golden	Region 3 Construction – Provo Canyon Crew	801-222-3436
C) Scott Andrus	Region 3 Construction	801-227-8029
D) Darin Sjoblom	UDOT Geotechnical Division	801-964-4474
E)		
F)		
G)		

14. Identify other Utah agencies, regional or national agencies, or other groups that may have an interest in supporting this study: